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Distribution of *Alternaria* species among sections. 4. Species formerly assigned to genus *Nimbya*

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Abstract—Morphological examination of phylogenetically unexamined species of the superseded genus *Nimbya* have permitted the inclusion of additional species in *Alternaria* sect. *Nimbya* (two species from monocots), *A.* sect. *Alternantherae* (two species from *Amaranthaceae*), and *A.* sect. *Porri* (one species from *Asteraceae*). Four other *Nimbya* species should be considered as taxa that are not distinguishable as unique within *A.* sect. *Alternaria*. *Alternaria* sect. *Alternantherae* now includes six species, *A.* sect. *Nimbya* includes six species, and *A.* sect. *Porri* consists of 118 morphospecies. To bring their nomenclature into accordance with modern *Alternaria* taxonomy, five new combinations and two replacement names are proposed for seven species previously accommodated in *Nimbya*.

Key words—*Alternaria crassoides*, *A. heteroschemos*, *A. juncicola*, *A. pimpriana*, *A. rhapontici*

Introduction

Alternaria Nees is a large, morphologically diverse genus that comprises approximately 280 distinguishable morphospecies (Simmons 2007). Recently, several series of morphological and phylogenetic studies have attempted to refine the phylogeny of *Alternaria* and other alternarioid hyphomycetes by utilizing more than ten different loci (Pryor & Bigelow 2003; Hong & al. 2005; Runa & al. 2009; Lawrence & al. 2012, 2013, 2014; Woudenberg & al. 2013, 2014; Armitage & al. 2015). Many well-supported lineages (phylogenetic species-groups) have been realized within the alternarioid hyphomycetes and have led to several taxonomic novelties. The genus *Alternaria* was recently divided into eight taxonomic sections by Lawrence & al. (2013) followed by the elevation of

19 additional clades by Woudenberg & al. (2013, 2014), Grum-Grzhimaylo & al. (2016), and Lawrence & al. (2016), bringing the total number of *Alternaria* sections to 27. Therefore, all former alternarioid hyphomycetes (13 genera) were transferred to *Alternaria*, including the type species of the genus *Nimbya*.

Nimbya was described by E.G. Simmons to cluster species characterized by specific septation and polygonal lumina in conidial transverse sections. In total, 17 *Nimbya* species have been proposed (Simmons 1989, 1995, 1997, 2000, 2004; Chen & al. 1997; Johnson & al. 2002; Zhao & Zhang 2005), of which 14 were established by E.G. Simmons: six species on *Amaranthaceae*, six species on monocots (*Cyperaceae*, *Juncaceae*), one species on *Asteraceae*, and one species on *Solanaceae*. The other three species were found on *Fabaceae*, *Caryophyllaceae*, and *Euphorbiaceae*.

A molecular phylogenetic study by Lawrence & al. (2012) revealed *Nimbya* as polyphyletic, with one group nested in *Alternaria* and the other closely related to *Embellisia* species. To resolve the polyphyly of *Nimbya*, Lawrence & al. (2012) divided *Nimbya* into the alternantherae species-group (strongly supported as sister to the alternata species-group) and *Nimbya* proper, which also correlated with plant hosts and morphological conidial characters. After all alternarioid hyphomycetes were collected under the single name *Alternaria*, four species (including the type of *Nimbya*, *N. scirpicola*) were placed in *Alternaria* sect. *Nimbya* (hosts from *Cyperaceae: Scirpus*, *Eleocharis*, and *Carex*) and four species were placed in *A.* sect. *Alternantherae* (hosts from *Amaranthaceae: Alternanthera*, *Celosia*, and *Gomphrena*).

These two sections are distinguished by several morphological characters (Lawrence & al. 2012, 2013, 2016; Woudenberg & al. 2013). Conidia in *A.* sect. *Alternantherae* are solitary or rarely paired; usually with long and filiform beaks; and in transverse sections lumina are distinctly delimited and hexagonal, octagonal, or rounded. Conidia in *A.* sect. *Nimbya* are solitary or in short chains of 2–8 units; rarely longitudinally septate; with extended and cone-shaped apical beaks; and in transverse sections lumina are rectangular, hexagonal, or encompass the entire volume. Some *A.* sect. *Nimbya* species have a known sexual state (formerly called *Macrospora*), which is morphologically similar to, but distinct from, other *Alternaria* teleomorphs, including those formerly called *Lewia* and *Allewia* (Lawrence & al. 2016).

Nine species of the former genus *Nimbya* are considered incertae sedis. The aim of this work was to examine the morphology of phylogenetically unexamined *Nimbya* species to determine their affiliation with any *Alternaria* sections. This work is a continuation of the series started with the manuscripts

on *Alternaria* sections *Porri*, *Alternaria*, *Infectoriae*, and *Pseudoalternaria* (Gannibal 2015, 2016; Gannibal & Lawrence 2016).

Materials & methods

The morphology of all *Nimbya* species was analyzed with regard to conformity with criteria of *Alternaria* sections. The morphological assessment was based on descriptions made by Simmons (1989, 1995, 1997, 2000), Chen & al. (1997), and Zhao & Zhang (2005).

Results & discussion

The *Alternaria* sectional affiliations of all 17 species formerly assigned to *Nimbya* are listed in Table 1. Evaluation of descriptions of nine *Nimbya* species allowed for their placement in *Alternaria*: two species from *Amaranthaceae* (*A. crassoides* from *Froelichia* and *A. pimpriana* from *Celosia*) were placed in *A.* sect. *Alternantherae;* two species from monocots (*A. heteroschemos* from *Carex* and *A. juncicola* from *Juncus*) should be considered members of *A.* sect. *Nimbya;* and species from other hosts were placed in *A.* sect. *Porri* (one species) and *A.* sect. *Alternaria* (four species).

Separation of cellular contents and formation of specific polygonal lumina in transverse conidial sections was found in many *Alternaria* species. Slight or distinct cellular content separation was fixed in Simmons's drawings (1997, 2000) for small-spored [≈ *A.* sect. *Alternaria*] and large-spored species [≈ *A.* sect. *Porri*]. We also observed this feature in many old herbarium specimens of different *Alternaria* species during other studies. Thus this feature is not unique for sections *Alternantherae* and *Nimbya*.

Nimbya rhapontici from *Asteraceae* has a relatively large conidial body and long filiform branched beak that is a characteristic feature of several *A.* sect. *Porri* species (Gannibal 2015; Lawrence & al. 2016).

Nimbya dianthi, *N. dolichi*, *N. euphorbiicola*, and *N. major* morphology fit the *A.* sect. *Alternaria* description (Gannibal 2016), but they have somewhat longer (≤67 µm) conidial bodies. All four species were described from herbarium specimens. Simmons (1995) observed that in the field small-spored *Alternaria* species produce conidia that are noticeably larger and differently shaped compared to conidia produced in culture.

Simmons (2007) described most *Alternaria* species using cultures grown under standardized conditions. There is no actual possibility to make appropriate comparisons of herbarium specimens with *A.* sect. *Alternaria* species described from artificial culture media. Moreover, morphology in *A.* sect. *Alternaria* sufficiently contradicts phylogeny (Peever & al. 2004,

2005; Andrew et al 2009). Many species were synonymized based on molecular data (Woudenberg & al. 2015). Therefore, *Nimbya dianthi*, *N. dolichi*, *N. euphorbiicola*, and *N. major* should be considered taxa that are not distinguishable as unique within *A*. sect. *Alternaria*.

To bring nomenclature in accordance with modern-day *Alternaria* taxonomy I propose the five new combinations and two replacement names listed below. As a result of this study *A*. sections *Alternantherae* and *Nimbya* now include six species each, while *A*. sect. *Porri* (Gannibal 2015) now includes 118 morphospecies.

Taxonomy

Alternaria crassoides (Davis) Gannibal, **comb. nov**.

MycoBank 822404

≡ *Cercospora crassoides* Davis, Trans. Wisconsin Acad. Sci. 21: 298 (1924)

≡ *Nimbya crassoides* (Davis) E.G. Simmons, Mycotaxon 55: 146 (1995)

Alternaria dolichi (T.Y. Zhang & G.Z. Zhao) Gannibal, **comb. nov.**

MycoBank 822503

≡ *Nimbya dolichi* T.Y. Zhang & G.Z. Zhao, Fungal Diversity 19: 207 (2005)

Alternaria heteroschemos (Fautrey) Gannibal, **comb. nov.**

MycoBank 822405

≡ *Macrosporium heteroschemon* Fautrey, Rev. Myco. (Toulouse) 18: 69 (1896)

≡ *Nimbya heteroschemos* (Fautrey) E.G. Simmons, Sydowia 41: 323 (1989)

Alternaria juncicola (E.G. Simmons) Gannibal, **comb. nov.**

MycoBank 822407

≡ *Nimbya juncicola* E.G. Simmons, Sydowia 41: 321 (1989)

Alternaria nimbyae-dianthi Gannibal, **nom. nov.**

MycoBank 822505

≡ *Nimbya dianthi* T.Y. Zhang & G.Z. Zhao, Fungal Diversity 19: 207 (2005)

Etymology: *nimbyae-dianthi* refers to the basionym, *Nimbya dianthi*.

Alternaria nimbyoides Gannibal, **nom. nov.**

MycoBank 822504

≡ *Nimbya euphorbiicola* W.Q. Chen & T.Y. Zhang, Mycosystema 16: 106 (1997)

Etymology: *nimbyoides* means similar to *Nimbya*.

Alternaria rhapontici (Nelen) Gannibal, **comb. nov.**

MycoBank 822406

≡ *Macrosporium rhapontici* Nelen, Bot. Mater. Otd. Sporov. Rast. Bot. Inst. Komarova Akad. Nauk S.S.S.R.15: 146 (1962)

≡ *Nimbya rhapontici* (Nelen) E.G. Simmons, Mycotaxon 65: 21 (1997)

Table 1. Homotypic *Alternaria* synonyms of *Nimbya* species, now assigned to *Alternaria* sections *Alternantherae*, *Alternaria*, *Nimbya*, and *Porri*.

References providing phylogenetic data shown in parentheses.
Unannotated names = species with reliable living cultures and herbarium specimens.
Bold font = species not previously assigned to any *Alternaria* section.
Asterisks = species for which no known living isolates are available.

Alternaria sect. *Alternantherae*

A. alternantherae Holcomb & Antonop.
(Lawrence & al. 2012, 2013; Woudenberg & al. 2013)
≡ *N. alternantherae* (Holcomb & Antonop.) E.G. Simmons & Alcorn

A. celosiicola Jun. Nishikawa & C. Nakash.
(Lawrence & al. 2012, 2013)
≡ *N. celosiae* E.G. Simmons & Holcomb

A. crassoides (Davis) Gannibal [*]
≡ *N. crassoides* (Davis) E.G. Simmons

A. gomphrenae Togashi
(Woudenberg & al. 2013)
≡ *N. gomphrenae* (Togashi) E.G. Simmons

A. perpunctulata (E.G. Simmons) D.P. Lawr., M.S. Park & B.M. Pryor
(Lawrence & al. 2012, 2013; Woudenberg & al. 2013)
≡ *N. perpunctulata* E.G. Simmons

A. pimpriana V.G. Rao [*]
≡ *N. pimpriana* (V.G. Rao) E.G. Simmons

Alternaria sect. *Alternaria*, indistinguishable taxa

A. dolichi (T.Y. Zhang & G.Z. Zhao) Gannibal [*]
≡ *N. dolichi* T.Y. Zhang & G.Z. Zhao

A. longipes* var. *major Pavgi & U.P. Singh [*]
≡ *N. major* (Pavgi & U.P. Singh) E.G. Simmons

A. nimbyae-dianthi Gannibal [*]
≡ *N. dianthi* T.Y. Zhang & G.Z. Zhao

A. nimbyoides Gannibal [*]
≡ *N. euphorbiicola* W.Q. Chen & T.Y. Zhang

Alternaria sect. *Nimbya*

A. caricis (E.G. Simmons) Woudenb. & Crous
(Pryor & Bigelow 2003; Hong & al. 2005; Lawrence & al. 2013; Woudenberg & al. 2013)
≡ *N. caricis* E.G. Simmons

A. heteroschemos (Fautrey) Gannibal [*]
≡ *N. heteroschemos* (Fautrey) E.G. Simmons

A. juncicola (E.G. Simmons) Gannibal
≡ *N. juncicola* E.G. Simmons

A. scirpicola (Fuckel) Sivan.
(Pryor & Bigelow 2003; Hong & al. 2005; Lawrence & al. 2012, 2013; Woudenberg & al. 2013)
≡ *N. scirpicola* (Fuckel) E.G. Simmons

A. scirpinfestans (E.G. Simmons & D.A. Johnson) Woudenb. & Crous (Lawrence & al. 2012, 2013).
≡ *N. scirpinfestans* E.G. Simmons & D.A. Johnson

A. scirpivora (E.G. Simmons & D.A. Johnson) Woudenb. & Crous (Lawrence & al. 2012, 2013).
≡ *N. scirpivora* E.G. Simmons & D.A. Johnson

Alternaria sect. *Porri*

A. rhapontici (Nelen) Gannibal [*]
≡ *N. rhapontici* (Nelen) E.G. Simmons

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Literature cited

Andrew M, Peever TL, Pryor BM. 2009. An expanded multilocus phylogeny does not resolve morphological species within the small-spored *Alternaria* species complex. Mycologia 101(1): 95–109. https://doi.org/10.3852/08-135

Armitage AD, Barbara DJ, Harrison RJ, Lane CR, Sreenivasaprasad S, Woodhall JW, Clarkson JP. 2015. Discrete lineages within *Alternaria alternata* species group: identification using new highly variable loci and support from morphological characters. Fungal Biology 119(11): 994–1006. https://doi.org/10.1016/j.funbio.2015.06.012

Chen WQ, Lin XF, Zhang TY. 1997. A new species of *Nimbya*. Mycosystema 16: 106–108.

Gannibal PhB. 2015. Distribution of *Alternaria* species among sections. 1. Section *Porri*. Mycotaxon 130(1): 207–213. https://doi.org/10.5248/130.207

Gannibal PhB. 2016 ["2015"]. Distribution of *Alternaria* species among sections. 2. Section *Alternaria*. Mycotaxon 130(4): 941–949. https://doi.org/10.5248/130.941

Gannibal PhB, Lawrence DP. 2016. Distribution of *Alternaria* species among sections. 3. Sections *Infectoriae* and *Pseudoalternaria*. Mycotaxon 131(4): 781–790. https://doi.org/10.5248/131.781

Grum-Grzhimaylo AA, Georgieva ML, Bondarenko SA, Debets AJM, Bilanenko EN. 2016. On the diversity of fungi from soda soils. Fungal Diversity 76(1): 27–74. https://doi.org/10.1007/s13225-015-0320-2

Hong SG, Cramer RA, Lawrence CB, Pryor BM. 2005. Alt a 1 allergen homologs from *Alternaria* and related taxa: analysis of phylogenetic content and secondary structure. Fungal Genetics and Biology 42: 119–129. https://doi.org/10.1016/j.fgb.2004.10.009

Johnson DA, Simmons EG, Miller JS, Stewart EL. 2002. Taxonomy and pathology of *Macrospora*/*Nimbya* on some North American bulrushes (*Scirpus* spp.). Mycotaxon 84: 413–428.

Lawrence DP, Park MS, Pryor BM. 2012. *Nimbya* and *Embellisia* revisited, with nov. comb. for *Alternaria celosiae* and *A. perpunctulata*. Mycol. Progress 11(3): 799–815. https://doi.org/10.1007/s11557-011-0793-7

Lawrence DP, Gannibal PhB, Peever TL, Pryor BM. 2013. The sections of *Alternaria*: formalizing species-group concepts. Mycologia 105(3): 530–546. https://doi.org/10.3852/12-249

Lawrence DP, Gannibal PhB, Dugan FM, Pryor BM. 2014. Characterization of *Alternaria* isolates from the infectoria species-group and a new taxon from *Arrhenatherum*, *Pseudoalternaria arrhenatheria* sp. nov. Mycological Progress 13(2): 257–276. https://doi.org/10.1007/s11557-013-0910-x

Lawrence DP, Rotondo F, Gannibal PhB. 2016. Biodiversity and taxonomy of the pleomorphic genus *Alternaria*. Mycological Progress 15(1):3 1–22. https://doi.org/10.1007/s11557-015-1144-x

Peever TL, Su G, Carpenter-Boggs L, Timmer LW. 2004. Molecular systematics of citrus-associated *Alternaria* species. Mycologia 96(1): 119–134. https://doi.org/10.2307/3761993

Peever TL, Carpenter-Boggs L, Timmer LW, Carris LM, Bhatia A. 2005. Citrus black rot is caused by phylogenetically distinct lineages of *Alternaria alternata*. Phytopathology 95(5): 512–518. https://doi.org/10.1094/PHYTO-95-0512

Pryor BM, Bigelow DM. 2003. Molecular characterization of *Embellisia* and *Nimbya* species and their relationship to *Alternaria*, *Ulocladium* and *Stemphylium*. Mycologia 95: 1141–1154. https:/doi.org/10.2307/3761916

Runa F, Park MS, Pryor BM. 2009. *Ulocladium* systematics revisited: phylogeny and taxonomic status. Mycological Progress 8: 35–47. https://doi.org/10.1007/s11557-008-0576-y

Simmons EG. 1989. *Macrospora* Fuckel (*Pleosporales*) and related anamorphs. Sydowia 41: 314–329.

Simmons EG. 1995. *Alternaria* themes and variations (112-144). Mycotaxon 55: 55–163.

Simmons EG. 1997. *Alternaria* themes and variations (151-223). Mycotaxon 65: 1–91.

Simmons EG. 2000. *Alternaria* themes and variations (244-286). Species on *Solanaceae*. Mycotaxon 75: 1–115.

Simmons EG. 2004. Novel dematiaceous hyphomycetes. Studies in Mycology 50(1): 109–118.

Simmons EG. 2007. *Alternaria*: an identification manual. CBS Biodiversity Series 6. 775 p.

Woudenberg JHC, Groenewald JZ, Binder M, Crous PW. 2013. *Alternaria* redefined. Studies in Mycology 75: 171–212. https://doi.org/10.3114/sim0015

Woudenberg JHC, Truter M, Groenewald JZ, Crous PW. 2014. Large-spored *Alternaria* pathogens in section *Porri* disentangled. Studies in Mycology 79: 1–47. https://doi.org/10.1016/j.simyco.2014.07.003

Woudenberg JHC, Seidl MF, Groenewald JZ, de Vries M, Stielow JB, Thomma BPHJ, Crous PW. 2015. *Alternaria* section *Alternaria*: Species, formae speciales or pathotypes? Studies in Mycology 82: 1–21. https://doi.org/10.1016/j.simyco.2015.07.001

Zhao GZ, Zhang TY. 2005. Notes on dictyosporous hyphomycetes from China VII. The genus *Nimbya*. Fungal Diversity 19: 201–215.